A MINIATURIZED FISSION IONIZATION CHAMBER FOR NEAR-SUN MISSIONS TO SEARCH FOR A QUASI-STEADY FLUX OF >1 MEV SOLAR NEUTRONS*

R.B. McKibben, J.J. Connell, and M. Zhang
Enrico Fermi Institute, University of Chicago, Chicago, IL 60637 USA,
mckibben@odysseus.uchicago.edu, FAX +1-773-702-6645

We have developed a prototype of a small yet sensitive neutron detector that could find application to a search for a possible quasi-steady flux of fast (>1 MeV) solar neutrons conducted on missions inward from the Earth toward the Sun, such as the ESA Solar Orbiter or the Bepi-Colombo Mercury Orbiter. To make such a search feasible on an interplanetary mission, our goal has been to develop a compact, high sensitivity detector, with the capability of performing a 10% measurement of a flux of 1 n cm^{-2} s^{-1} in 24 hours for a mass less than 1.5 Kg and power consumption less than 2 W. While it is well known that fast neutrons can be produced in large solar energetic particle events, discovery of a quasi-steady fast neutron flux would imply the near-continuous presence of energetic nucleons with energies of a few MeV at the Sun, providing important new information about energetic processes in the lower solar atmosphere. Searches for a low-level neutron flux from Earth are hampered not only by the $1/r^2$ fall-off in flux with radius, but also by the short half-life of neutrons, which results in most neutrons with energies less than a few MeV decaying before they reach 1 AU. Our instrument concept is based upon detection of neutron-induced fission from foils of fissionable material (e.g. Thorium or Uranium) in a compact pulse ionization chamber. With our prototype chamber we have demonstrated clean detection of neutrons with sensitivity consistent with our target in a sensor that, together with its electronics and housing, would meet our mass and power targets, making it feasible for inclusion on modest-scale interplanetary spacecraft. We will describe our development effort to date, and discuss our plans for continuing the development process.

*This work has been supported in part by NASA Grant NAG5-7163.